15:21:30 OCA PAD INITIATION - PROJECT HEADER INFORMATION 03/22/90

Active

Project #: B-10-620 Cost share #: Rev #: 0
Center # : 10/24-6-R6658-1A0 Center shr #: OCA file #:
Work type : RES
Contract#: SUBCONT DTD 12/15/88 Mod #: Document : SUBCONT
Prime #: 5 R01 HL42052-02 Contract entity: GTRC

Subprojects ? : N
Main project #:

Project unit: OIP Unit code: 03.010.106
Project director(s):
EZQUERRA N F OIP (404)894-7026

Sponsor/division names: EMORY UNIVERSITY / ATLANTA, GA
Sponsor/division codes: 400 / 012

Award period: 891201 to 901130 (performance) 901130 (reports)

Sponsor amount	New this change	Total to date
Contract value	86,737.00	86,737.00
Funded	86,737.00	86,737.00
Cost sharing amount		0.00

Does subcontracting plan apply ?: N

Title: UNIFIED APPROACH TO QUANTIFY AND VISUALIZE CARDIAC IMAGERY

PROJECT ADMINISTRATION DATA

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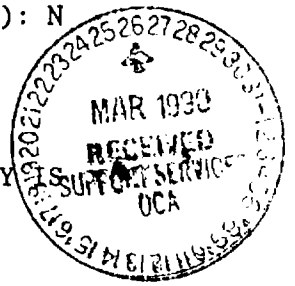
Security class (U,C,S,TS) : U ONR resident rep. is ACO (Y/N): N
Defense priority rating : N/A N/A supplemental sheet
Equipment title vests with: Sponsor X GIT
NONE PROPOSED
Administrative comments -
THIS IS A FOLLOW-ON TO B-10-611. (SEPARATE BUDGET-YEAR ACCOUNTABILITY IS REQUIRED)



GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

NOTICE OF PROJECT CLOSEOUT

Closeout Notice Date 04/02/91

Project No. B-03-620 Center No. 10/24-6-R6658-1A0

Project Director EZQUERRA N F School/Lab BEC

Sponsor EMORY UNIVERSITY/ATLANTA, GA

Contract/Grant No. SUBCONT DTD 12/15/88 Contract Entity GTRC

Prime Contract No. 5 R01 HL42052-02

Title UNIFIED APPROACH TO QUANTIFY AND VISUALIZE CARDIAC IMAGERY

Effective Completion Date 901130 (Performance) 901130 (Reports)

Closeout Actions Required:	Y/N	Date Submitted
Final Invoice or Copy of Final Invoice	Y	901130
Final Report of Inventions and/or Subcontracts	Y	
Government Property Inventory & Related Certificate	Y	
Classified Material Certificate	N	
Release and Assignment	N	
Other	N	

Comments CONTINUED BY B-03-603

Subproject Under Main Project No.

Continues Project No.

Distribution Required:

Project Director	Y
Administrative Network Representative	Y
GTRI Accounting/Grants and Contracts	Y
Procurement/Supply Services	Y
Research Property Managment	Y
Research Security Services	N
Reports Coordinator (OCA)	Y
GTRC	Y
Project File	Y
Other	N
	N

NOTE: Final Patent Questionnaire sent to PDPI.

Memorandum

DATE: 21 March 1991
TO: K. Ehlinger
FROM: N. Ezquerra
SUBJECT: B-03-620

I am enclosing a document which serves to fulfill the deliverable requirement for the subject contract with Emory University.

Please note that the attached document is a grant renewal report that has already been submitted to NIH, and is a joint effort between our Emory-Ga Tech research team.

XC: (2 copies) w/rpt. off-print sheet

DH 3/25/91

1. SUMMARY OF OBJECTIVES AND SPECIFIC AIMS FOR NEXT YEAR OF SUPPORT

The overall objective of the research continues to be to develop and validate a computer-based methodology to quantify, visualize, and unify anatomic information derived from coronary arteriography and physiologic information derived from myocardial perfusion tomography.

The most significant achievement during the second year of research was the development and initial validation in phantoms of a computer algorithm to unify into a single quantitative display the reconstructed 3D arterial tree with the reconstructed 3D myocardial perfusion distribution. The importance of this achievement in terms of research in the field is that this algorithm is the first to allow such unification from patient specific information. The importance of this achievement in terms of problems of heart and vascular diseases is that the integration of anatomic and physiologic information obtained independently from these two cardiac imaging modalities should result in the improved assessment of the extent and severity of coronary artery disease. Moreover, subsequent clinical utilization of this technique could help unlock the mystery as to why some patients exhibit myocardial perfusion abnormalities in the absence of coronary artery disease.

The specific aims of the research for the next year of support are generally the same as those originally proposed. These objectives are as follows:

(1) To continue to refine and extensively validate computer algorithms for reconstructing and generating quantitative, patient-specific, three dimensional (3D) arterial maps obtained from simultaneous, biplane, digital coronary angiography.

(2) To continue to refine and extensively validate computer algorithms for generating 3D quantitative, myocardial perfusion distributions obtained from single photon emission computerized tomography using thallium-201 and a new perfusion tracer, Tc-99m-MIBI.

(3) To continue to the develop and validate a computer algorithm for registering, quantifying and visualizing in 3D a unified model of the coronary tree superimposed on the myocardial perfusion distribution.

Whereas during the first year of the proposal we emphasized the developments in (1) and (2) above and during the second year in (3), during the third year we will emphasize the initial validation and

application in animals and patients of each of these three phases of development.

The experimental design and methods for achieving these goals are basically the same as those described in the initial proposal. More specifically, what we expect to accomplish in the three major areas of development is as follows:

Development of methods for the quantification and visualization of anatomic information from coronary arteriographic studies.

We will analyze results from implementing these algorithms in biplane angiographic studies from animal experiments and conventional patient procedures. We expect to find patient and animal studies which will make the algorithm fail to some degree making further modifications and improvements necessary. We will continue to automate and objectify the reconstruction procedure by improving the detection of vascular structures by modifying the edge detection technique described in detail in [1]. We will continue to improve operator interaction to facilitate manual editing. We will continue to develop a knowledge-based artificial intelligence approach to tracking and isolating the various vessels which might superimpose on the two-dimensional planar projections. We will continue develop methods described in [2] to reconstruct and display in an animated format sequential, simultaneous, biplanar angiograms in order to quantify and visualize the important temporal information yielded by these studies.

Development of methods for the quantification and visualization of physiologic information from myocardial tomographic studies of radioactive perfusion tracers.

We will analyze results from implementing these algorithms in myocardial perfusion SPECT studies from animal experiments and routine patient procedures. We will document improvements to our present methods of sampling the myocardial count distribution described in [3] and [4] for the surface model of perfusion by emphasizing computer techniques which sample perpendicular to the myocardial wall. We will continue to use this count distribution not only to render and quantify myocardial perfusion but also as a parameter of myocardial thickness and thickening which may also be used to quantify myocardial mass as described in [5]. We will apply these methods in the animal and patient studies for correlations with MRI as an independent measurement of regional wall thickness and myocardial mass. We will use this myocardial thickness information to start development of the volumetric (rather than surface) model of the myocardium in 3 and 4 dimensions. We will investigate various four-dimensional filtering techniques to improve our rendering and animated display of surface models of 4-dimensional perfusion distributions (3D + time). We will implement in the 3D displays the techniques developed to quantify reversibility as a marker of myocardial ischemia as described in [6] and [7].

Development of methods for the unified quantification and visualization of anatomic and physiologic information in 3 and 4 dimensions.

We will analyze results from implementing these algorithms to unify the angiographic and SPECT studies from animal experiments and routine patient procedures. The initial validation will be done using end-diastolic distributions. Whereas in the second year we were successful in rendering the dynamic course of the contracting coronary tree [2] and independently the myocardial mass [4] during the third year we will commence the unification of these two distributions in a combined display. We will also continue to develop the techniques described in projects 3.3 and 3.4 of the original proposal to quantify the extent and severity of stenotic lesions based on myocardial mass and perfusion.

2. STUDIES CONDUCTED DURING THE CURRENT BUDGET YEAR

Significant progress was achieved during the current budget year toward fulfilling the goals of the proposed research. The studies conducted and milestones achieved are described below including references found in the Publications section and Appendix.

A number of our manuscripts appeared (or are about to appear) in the literature resulting from our efforts during the first and second years of this grant. In particular these manuscripts were related to the following accomplishments:

1. The development and initial validation of a computer algorithm to reconstruct from a limited number of arbitrary angiographic projections, and using non-parallel geometry, the patient's coronary arterial tree in three-dimensional (3D) space: [1] and [2].

2. The development of computer algorithms for quantification and visualization of the 3D myocardial perfusion distribution using the heart's actual dimensions: [3] and [4].

3. The development of a new sampling method for more accurately extracting the 3D myocardial perfusion distribution using a combination of spherical coordinates for sampling the apex and cylindrical coordinates for sampling the rest of the myocardium: [3] and [4].

4. The development and validation of methods for estimating the effects of wall thickness on the recovered counts which may be used for the eventual measurements of wall thickness or thickening necessary for the development of volumetric models of myocardial perfusion: [5]

5. The development of an algorithm to quantify and visualize perfusion defect reversibility between stress and rest as a marker of myocardial ischemia [6] and a prospective validation of

the method using a large patient population [7]

Other accomplishments not reported yet:

6. The development of methods to unify the angiographic and perfusion end-diastolic information.

7. The initial validation of this unification in phantoms.

8. The utilization of the 3D myocardial perfusion display approach to help differentiate patients with left bundle branch block (LBBB) with CAD exhibiting a large heart and apical hypoperfusion from patients with LBBB and no CAD.

9. The development of methods and clinical implementation of the 3D myocardial thickening display as a marker of viability.

3. **FOR PROTOCOLS INVOLVING THE USE OF IMAGES FROM PATIENT STUDIES NO CHANGES IN THE PROTOCOLS WERE PERFORMED OR ARE PLANNED FOR THE COMING YEAR.**

4. **FOR PROTOCOLS INVOLVING THE USE OF VERTEBRATE ANIMALS NO CHANGES IN THE PROTOCOLS WERE PERFORMED.** We are considering to modify our animal experiments such that instead of using the canine model we would use the porcine model which might be more appropriate, less expensive (allowing for more experiments). If we do decide to switch we will first obtain the necessary permissions from the IACUC.

5. **PUBLICATIONS**

[1]. Peifer J, Cooke D, Klein L, Garcia EV: Quantification and Visualization of 3D Cardiac Imagery. IEEE Trans on Biomed. Engineering, Vol. 37, No. 8, August 1990.

[2]. Peifer JW, Mullick R, Ezquerra NF, Hyche E, Garcia EV, Klein L, Cooke CD: Coronary Vasculature Visualization from Limited Angiographic Views. Proceedings of the First Conference on Visualization in Biomedical Computing, Atlanta, GA, May 22-25, IEEE Catalog # 90TH0311-1, pp 195-200, 1990.

[3]. Cooke CD, Garcia EV, Folks RD, Peifer JW, Ezquerra NF: Visualization of Cardiovascular Nuclear Medicine Tomographic Perfusion Studies. Proceedings of the First Conference on Visualization in Biomedical Computing, Atlanta, GA, May 22-25, IEEE Catalog # 90TH0311-1, pp 185-189, 1990.

[4]. Garcia EV, Cooke CD, Van Train K, Folks RD, Peifer JW, DePuey EG, Maddahi J, Alazraki N, Galt JR, Ezquerra NF, Ziffer J, Berman D: Technical Aspects of Myocardial SPECT Imaging with Tc-99m Sestamibi. Am J Cardiol, 1990. (In press)

[5]. Galt JR, Garcia EV, Robbins W: Effects of Myocardial Wall

Thickness on SPECT Quantification. IEEE Trans. Med. Imaging, 9(2):144-150.

[6]. Klein JL, Garcia EV, DePuey EG, Cambell J, Taylor AT, Pettigrew RI, D'Amato P, Folks R, Alazraki N: Reversibility Bullseye: A New Polar Bullseye Map to Quantify Reversiblity of Stress Induced SPECT Tl-201 Myocardial Perfusion Defects. J Nucl Med, 31:1240-1246, 1990

[7]. Garcia E, DePuey EG, :Quantification of Reversibility of Stress Induced SPECT Tl-201 Myocardial Perfusion Defects: A multicenter trial using Bullseye polar maps and standard normal limits. ,J Nucl Med. (In press)